POLLUTION PREVENTION

ALTERNATIVES TO HAZARDOUS SOLVENTS

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Evaluation of Solvent Substitutes

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Many solvent users are seeking alternative methods for **parts cleaning and surface preparation.** Regulatory and economic pressures stemming from the environmental and health effects of solvents have lead to a search for less hazardous substitutes. Many companies have already converted to cleaning alternatives that reduce costs and regulatory requirements while reducing the liability of waste, air emissions, and worker safety.

Though many solvent users seek a "safer solvent" that will perform identically in their current cleaning system, there are many *non-solvent* alternatives to be considered also, including water-based and abrasive / mechanical cleaning. (See Solvent Substitution Options, Ecology publication #96-420, for a list of options.)

The following steps can be used in evaluating parts cleaning alternatives. It will help you to select solvent substitutes that meet your needs and priorities while minimizing unforeseen problems and cost over-runs.

Step 1: Determine Your Priorities

List the problems with your current cleaning system that are driving the need to make a change. Rank these problems in order of importance and provide a goal for each. Some concerns may include the following:

- ✔ Cost.
- ✔ Regulatory requirements (hazardous waste disposal, CERCLA, SARA 313 and Toxics Release Inventory, occupational health and safety, wastewater disposal restrictions, fire codes, air permits, labeling for ozone depleting chemicals).
- ✔ Worker exposure and safety; working conditions.
- ✔ Environmental liability.
- ✔ Perceptions of the surrounding community.
- ✔ Increase in production capability.
- ✔ Quality of cleaning.

Step 2: Review Your Cleaning Needs

Why are you cleaning? Purposes for cleaning may include:

- ✔ aesthetics
- ✔ organic coating adhesion
- ✔ dimensional tolerance
- ✔ corrosion protection
- ✔ weldability
- ✔ conversion coating adhesion
- ✔ remanufacturing plating

Name and rank the most important advantages and disadvantages of your current solvent. These may include properties such as:

- ✔ evaporation rate
- ✔ time required to clean
- ✔ degree of cleanliness
- ✔ presence of residues
- ✔ substrate compatibility
- ✔ toxicity and hazard
- ✔ separating cleaner from oils and greases
- ✔ compatibility with waste treatment system
- ✔ can be recycled

What is your production rate? For production cleaning, what is the maximum amount of time that a part could spend in a cleaning step?

How clean must the parts be?

- ✔ What are your minimum functional cleanliness requirements (e.g., meeting paint adhesion requirements, plating quality, etc.)? See Ecology Publication #96-423, "Optimizing Your Parts Cleaning System".
- ✔ Are there contract specifications for cleanliness that must be followed?
- ✔ Are there industry tests, standards or recommendations for your purposes?

If specifications or standards do not exist, select a convenient method for testing cleanliness, and use it to determine the minimum cleanliness acceptable to you and your customers. This will help to minimize the expense of over-cleaning. Look for ASTM cleanliness and performance testing standards (your local library may be able to assist you). For further information on testing methods, you may wish to obtain an article by Anselm T. Kuhn, titled "Is It Clean? Testing for Cleanliness of Metal Surfaces", which appeared on page 25 of the periodical *Metal Finishing*, September 1993. You local library may be able to locate this issue, if necessary.

Can cleaning be eliminated or reduced? Measures that may reduce or eliminate the need to clean could include:

- ✔ Modify upstream / downstream processes to avoid or reduce need to clean.
- ✔ Use greaseless or water-based binders for buffing.
- ✔ Reduce the entry of tramp oils into machine coolants and cutting oils.
- ✔ Reduce contamination during storage, transport, and handling.
- ✔ Specify that parts are delivered to your shop clean.
- ✔ Reduce the number of times a part is cleaned.
- ✔ Switch to lubricants or coolants that are more easily cleaned by your system.

Step 3: Can You Meet Your Goals By Optimizing Your Current System?

You may be able to solve your cleaning problems and meet the goals you set in Step 1 by modifying your current equipment or procedures. In some cases this could provide a cost effective solution. Optimizing measures might include:

- ✔ Make sure that your cleaning system is installed and operated according to the manufacturer's instructions.
- ✔ Pre-clean parts to remove heavy contamination and increase cleaner life. A dirtier, "sacrificial" cleaning tank might be used before the main cleaning operation.
- ✔ Monitor the cleaner's cleaning ability prior to replacing: when is it really too spent to perform adequately?
- ✔ Remove sludge on a routine basis.
- ✔ Use tight-fitting lids to prevent solvent loss from evaporation.
- ✔ Refurbishing your cleaner to extend its useful life. Filters on parts washers have been shown to greatly extend cleaner life. Gravity separation can divide sludge and oils from some cleaners. Distillation can be used to purify many solvents.
- ✔ Prevent contamination of cleaner with trash, other liquids (especially chlorinated solvents like carburetor cleaner, lubricants, and aerosols).
- ✔ Automate the cleaning process.
- ✔ Use countercurrent processes (use dirty solvent for initial cleaning and clean solvent for final cleaning).
- ✔ Reduce drag-out of cleaner.
- ✔ Optimize heat, agitation, retention time, etc. (temperatures should be kept 50^{o} F below the flash point to limit fire hazard).
- ✔ Improve water purity.
- ✔ Centralize and consolidate cold cleaning to minimize vapor losses.

Step 4: Screen Preliminary Alternatives

If your are looking for a replacement for your current solvent or cleaning system, see Ecology Publication #96-420, "Solvent Substitution Options". You may wish to screen alternatives by considering the following factors:

- ✔ What kind of soil are you cleaning (shop dust, metal fines, scale and smut, flux, cutting oils and coolants, waxes, fingerprints)?
- ✔ What kind of substrates are you cleaning?
- ✔ What part sizes are you cleaning?
- ✔ Will cleaning be done on a batch or continuous basis?
- ✔ What is the geometry of the part? Does it have blind holes, scored surfaces, or other features that are difficult to clean, or that require a specific method of applying the cleaner?
- ✔ Can the cleaner be used with the necessary application method?
- ✔ Could the system damage the part?
- ✔ How well do the alternatives meet the goals, priorities, and specifications in Steps 1 and 2?
- ✔ Is the alternative less hazardous to the environment and your workers than your current cleaner?

Step 5: Do Bench Testing

Some cleaning methods can be tested on a small scale to reduce the cost and risk involved in experimenting on a larger scale. Small scale "bench-top" tests provide preliminary performance data that can help you further screen the alternatives selected in Step 4 to determine whether they will meet your overall goals, priorities, and criteria. Bench tests can also supply valuable data for designing your cleaning system.

Some suppliers will test their products on parts you send to their laboratories. Or you may be able to do the testing at your own facility. Actual soiled parts can be used, if small enough, and have the advantage of allowing you to test a piece as it is actually configured. An alternative is to prepare "coupons"— small, uniform test strips made of material from which the parts are manufactured.

Cleaning systems should be simulated in small containers that allow you to test factors such as:

- ✔ optimum cleaning time, temperature, agitation, pH, concentration, pressure, flow rates, drying time, and other operational variables
- ✔ whether the cleaned part will pass the necessary tests for cleanliness, corrosion, adhesion, strength or other performance criteria
- ✔ composition and toxicity of the fresh and spent cleaner
- ✔ how well the cleaner can be filtered, distilled, recycled, separated, or treated

Step 6: Do A Detailed Evaluation of Qualifying Alternatives

Cleaning alternatives that pass the bench tests should be further analyzed for suitability, technical feasibility, and cost. Both your current (optimized) system and the alternatives should be analyzed and compared, and then checked against the goals, priorities, and criteria identified in Steps 1 and 2. The results of this evaluation will be used to select one or more cleaning systems to test on a larger scale. If existing cleaning systems do not perform adequately, some suppliers are willing to reformulate their products to meet specific needs.

Technical feasibility

- ✔ How will "down stream" processes be affected?
- ✔ Does the cleaner contain regulated VOCs (volatile organic compounds), ozone depleting chemicals, biocides, or other regulated hazardous substance?
- ✔ If new waste streams or emissions are created, what are their quantities and characteristics? How must these new wastes be managed and disposed?
- ✔ How will permitting, reporting, or monitoring requirements be affected?
- ✔ Is the cleaner less hazardous than your current one? Will additional safety procedures, equipment, monitoring, or training be necessary? (Refer to the product MSDS or manufacturer for information on worker exposure limits, hazards, and precautions.)
- ✔ Can the cleaner be recycled? Can its life be extended through filtration, skimming, separation, distillation, etc.?

- ✔ Will it cause concern in the surrounding community? Will it increase odors, dust, noise, chance of accident, etc.?
- ✔ Will the cleaning process and its maintenance require more or less labor?
- ✔ Can existing equipment be used or modified? Will the materials be compatible?
- ✔ Will facility modifications be needed (plumbing, ventilation, fire/explosion proofing, resizing doors, etc.)?
- ✔ Will it affect your wastewater treatment system?
- ✔ Will it affect your production time?
- ✔ Will your local sewage treatment plant accept the waste?
- ✔ Does it generate more or less solid waste or hazardous waste?
- ✔ Will more worker training or safety equipment be required?
- ✔ Will there be adequate vendor support and training, especially during start-up?
- ✔ Are your existing chemical handling facilities and practices adequate?
- ✔ Is there enough floor space?
- ✔ Are the utilities adequate?
- ✔ Is there worker acceptance? Will training and/or incentives help this?
- ✔ Where else has the cleaning system been used, and what were the results?

Cost analysis

Will costs for the following increase or decrease in future years?

- ✔ purchase of raw materials
- ✔ waste disposal
- ✔ pollution control
- ✔ labor
- ✔ maintenance
- ✔ utilities (water, wastewater treatment and disposal, energy, garbage and recycling, cooling and heating, ventilation, emission controls)
- ✔ system purchase, engineering, installation, facility modification, utility connections
- ✔ parts and supplies
- ✔ storage, containers
- ✔ permits, sampling and testing, record-keeping, oversight
- ✔ worker safety equipment, monitoring, training
- ✔ spill response equipment, training, planning
- ✔ insurance
- ✔ liability
- ✔ quality control and reworking of defects
- ✔ marketing, public relations, and company image
- ✔ inventory handling, shipping
- ✔ depreciation, taxes and tax credits
- ✔ salvage value
- ✔ down time
- ✔ revenues from products, by-products, and recycling
- ✔ credit costs
- ✔ legal fees
- ✔ training

Step 7: Do Pilot Testing

The detailed evaluation done in Step 6 should have pointed to one or more preferred alternatives to test on a larger scale or under more realistic conditions. Test this candidate system on a limited production basis or as a replacement for a portion of your cleaning needs. During this pilot testing, record the same type of information collected during bench testing (Step 5). Use this opportunity to fine-tune the system, gather worker feedback, gauge customer satisfaction, and measure the consistency and reliability of the system's performance. Use the results of the pilot test to determine how well the system meets your original priorities, goals, and criteria of Steps 1 and 2.

Step 8: Handling Start Up of a New System

Anticipate having to make adjustments during the start-up phase of a new cleaning system. Be prepared for production interruptions and adjustments to concentrations, flow rates, temperatures, cycle times, nozzle alignment, power input, agitation, and filtration. Worker training, feedback, and flexibility can be critical during this phase.

Step 8: For More Information

Ecology has experienced Pollution Prevention Consultants available to advise you on solvent substitution techniques and issues. They can provide information over the telephone, or make educational (non-enforcement) visits to your work site to provide free technical assistance on solvent substitution, economic considerations, pollution prevention opportunities, and suppliers. Use the regional phone numbers below to ask for a Toxics Reduction Specialist.